



Linking SDR and PC

Mike Richards G4WNC is looking this month at how you connect an SDR transceiver to your PC. It uses cables as you'd expect – they just happen to be virtual ones.

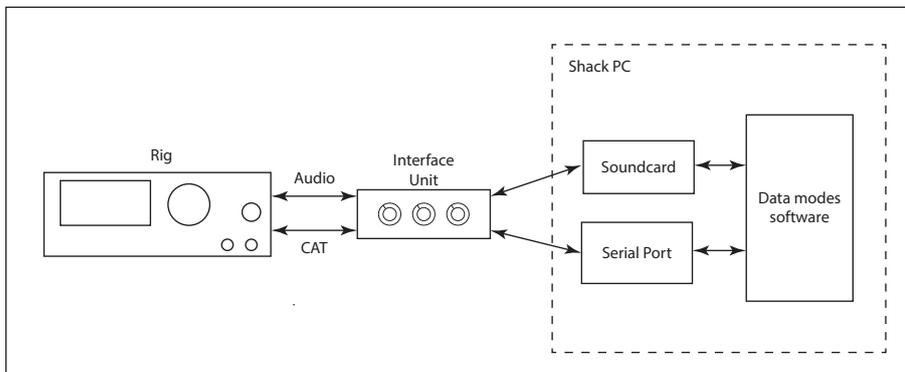


Fig. 1: Typical data modes setup using an interface unit.

With the rapid introduction of all manner of SDR rigs over the past few years, it's time to take a look at an area that's a common source of reader confusion and queries – virtual connections.

Prior to the introduction of SDR technology, the links between your rig and any computer based software were handled using physical cables that had to be plugged into the back of the PC and the rig. This process was usually enhanced by some form of interface unit. The main role of the data modes interface was to provide a degree of electrical isolation between the sensitive rig and your, potentially, very noisy PC. In addition, the interface usually added some additional switching controls to assist CAT control or PTT operation as well as audio level controls so that the operator could more easily adjust the transmit and receive drive levels, Fig. 1. This technology has worked very well and many interfaces do an excellent job of making data modes operation trouble-free. The advent of SDR based rigs, where the hardware operates

entirely under control of the PC, creates a new set of problems that I'll try to clarify here.

Why Virtual

In most cases, it's still possible to use physical leads to link an SDR receiver to data modes or other software running on your PC, Fig. 2. However, this isn't a good idea and reduces the quality of your station. Let's start by taking a look at the audio path. When running an SDR rig with software running on the PC, the demodulation of the signal is usually carried out in the PC. The output is a digital audio stream that needs to be sent to something that can make use of the signal. If we were operating phone, then the digital audio could be sent to a soundcard in the PC, where it would be converted to a conventional analogue signal that can be heard using headphones or a loudspeaker. The conversion from a digital audio stream

to an analogue signal is performed by a Digital to Analogue Converter (DAC) chip.

Let's use an 8-bit digital signal as an example to better understand what happens. In an 8-bit digital audio stream, the signal has a maximum of 256 possible levels or steps ranging from 0V to the maximum output voltage. The resulting output signal has a rough edge as shown in Fig. 3. While the process works remarkably well, the use of just 256 steps to convey an analogue signal means that some of the original signal will have been lost. Let's now look at the opposite direction where we want to send an analogue signal into the SDR rig. To convert the signal to a digital format we need to use an Analogue to Digital Converter (ADC). This is the opposite of the DAC in that it measures the incoming signal voltage and stores the result as a digital number. The measurement frequency is determined by the Nyquist theorem, which requires that we take measurements at least twice as quickly as the highest frequency in the audio signal. In an 8-bit system, we have the same problem as the DAC example because we only have 256 voltage steps available to represent the incoming signal. The sampling process will break the signal into these predefined levels and pass them on as a serial digital signal. The crunch here is that by converting our analogue signal to digital, we will have lost information and so reduced the quality. The net result is that by converting to analogue and back to digital as in Fig. 2, we will have been through two conversion processes with

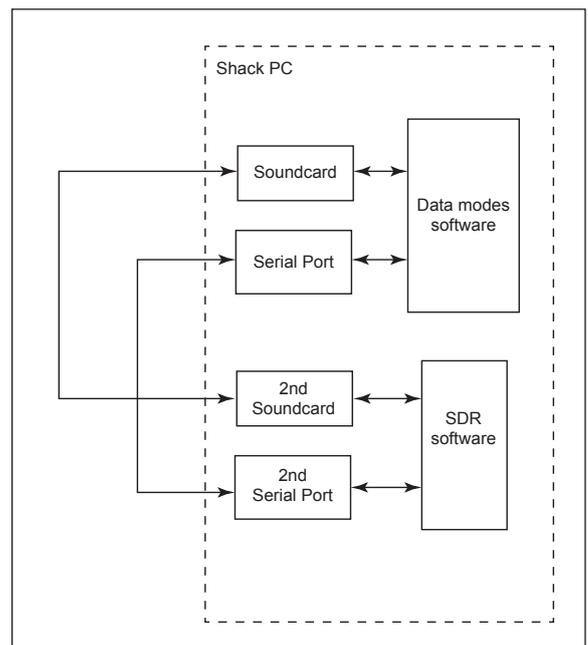


Fig. 2: Connecting an SDR and decoder using physical leads – not a good idea!

each one reducing the signal quality. What we need is a lossless way to get our signal from the SDR to the decoder or other software. That's exactly what a Virtual Audio Cable (VAC) does.

Virtual Audio Cable

A VAC is a software package that you load on to your PC and it installs as a new audio device that will be visible as such in all your software. As an example, I have **Engine Muzychenko's** excellent VAC installed on my system and this shows up in Windows as Line 1 (Virtual Audio Cable) when I open my sound devices in Windows. You can get Engine's software from the website below.

<http://goo.gl/RDHvkh>

As you can see from **Fig. 4**, the VAC shows up in both the Recording and Playback Devices. It's the fact that the VAC appears as both a recording and playback device that makes it so versatile. It creates a two-way link between the recording and playback system. To make use of the VAC, all I have to do is to open my SDR software and direct its audio out and audio in to Line 1 Virtual Audio Cable. I can then open my data modes software such as FLDIGI and set the audio input and output to the same Line 1 Virtual Audio Cable as shown in **Fig. 5**. The immediate benefit of a VAC connection comes from the fact that the link is purely digital. All the VAC does is to pass the digital audio stream from one application to the other without any data conversion. This makes the connection completely lossless, thus preserving the quality of the original signal. That alone would be a worthwhile

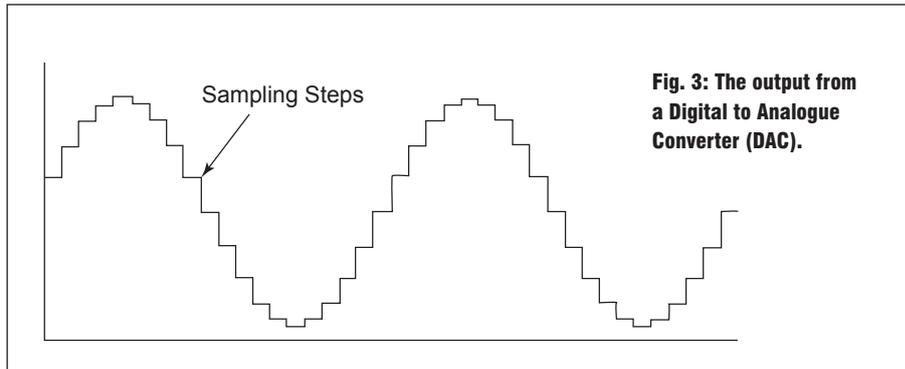


Fig. 3: The output from a Digital to Analogue Converter (DAC).

benefit but there's more. The VAC is able to support multiple connections, which means that you could connect several data modes decoders to the same VAC. Each one receives its own feed and there is no interaction between the feeds. This can be very helpful when dealing with difficult signals during contests, for example. By running several decoders in parallel, you can choose the output from the most successful decoder.

While the VAC does a great job of making loss-free connections between software, you may also want to listen to the audio from your receiver. To do that, you need to use another application that's also supplied with Eugene's software. This provides a repeater function that takes its input from any of the PC's audio input devices and routes it to any output device. In the case of our data modes software, we can point the repeater's input to the Line 1 (Virtual Audio Cable) and set the output to your computer's speakers, **Fig. 6**. The Audio Repeater that is bundled with Eugene's software works really well and includes additional routing choices for the audio. After you've set the inputs and output, you have to start the repeater and the Queue bars will begin to move. These

bars and the Overflow and Underflow indicators let you know that everything is working correctly. If you see any Overflows or Underflows, it's a sign that your processor's struggling. The repeater supplied with Eugene's software is very flexible and you can run multiple repeaters from the same source.

An alternative VAC, VB-CABLE is available from VB-Audio as donation-ware, so you are encouraged to make a donation to support the development. The web address appears below.

<http://goo.gl/EjbnZE>

Once installed, VB-CABLE provides a single VAC that you can use to connect multiple decoders and other facilities. VB-Audio doesn't include an audio repeater so you'll need to find an alternative application for that. The best solution I've found is Sound Tap and that's available free from the website below. www.k3pgp.org/software.htm

Rig Control

The established standards for rig control are based around the use of old RS-232 or similar serial interfaces. These have been extinct for many years now but the underlying technology has remained

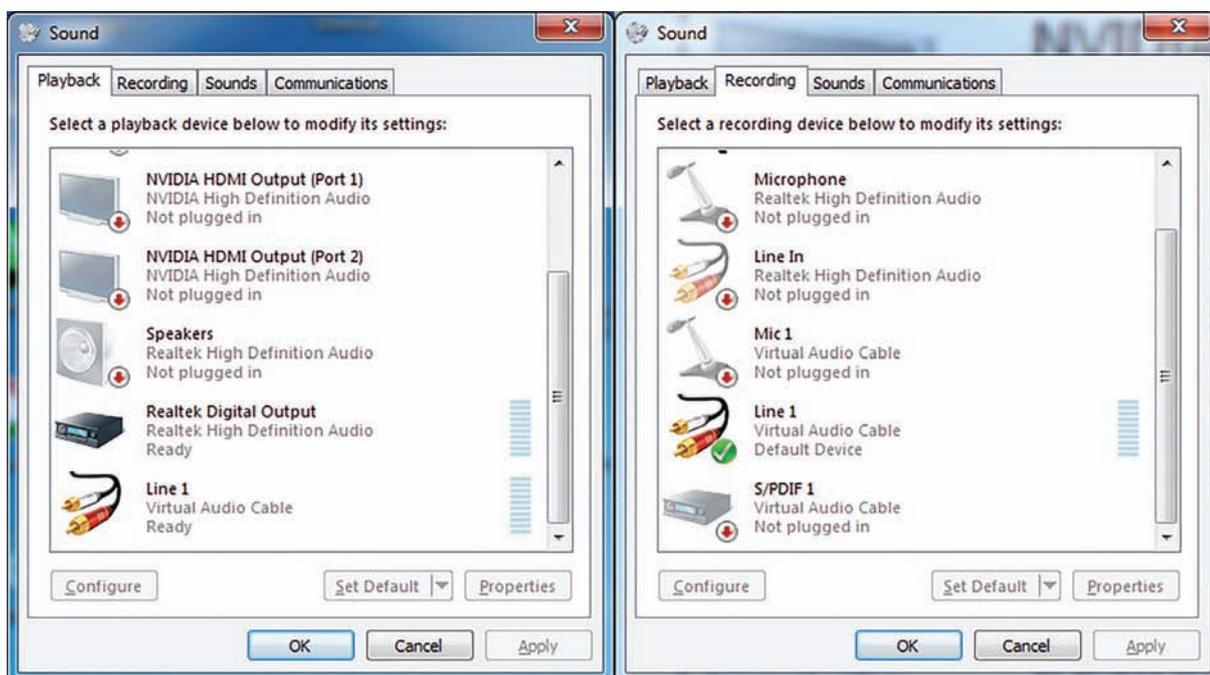


Fig. 4: Windows Recording and Playback device panels showing the VAC.

and is still in use. The solution for most stations is to use a USB to serial converter to manage the physical link between the rig and the software. When using a data modes interface, you will often find a conversion cable included. However, once we start using SDR rigs we are faced with a situation where we could be sending the CAT commands via a USB to serial adapter and then taking them back into the PC via another USB to serial adapter. This is clearly silly and there is a simple software solution to tidy this up. The answer is to use a virtual serial cable or a null modem emulator. Much like the VAC I mentioned earlier, this is an entirely software-based solution that creates pairs of connected COM ports. The most popular and free solution is com0com, available from the website below.

<http://goo.gl/ugwvFF>

Once installed, com0com creates connected pairs of software or virtual COM ports on your PC. The com0com software is very flexible and you can install unlimited pairs of connected COM ports. The ports can be controlled via the setup application that you will find via the Windows start menu. Once opened, this will give you the display shown in **Fig. 7**. Here you can add, remove and configure ports. The default will give you a pair of ports named CNCA and CNCB, which is probably all that's required for most stations. If you need to add or remove ports, just use the Add Pair button. When you add pairs, Windows will automatically recognise the new ports and load the appropriate drivers. At the time of writing, the current version 3.0.0.0 has a problem with Windows 64-bit operating systems because its drivers are unsigned and so get kicked out by Windows security. You can overcome this by putting Windows into test mode but that compromises your PC's security so it's not the best solution. The simplest answer is to download the older version, 2.2.2.0, because that includes 64-bit signed drivers and has all the features we need for simple CAT control and other amateur radio applications.

When using virtual COM ports, you will note that we have two linked COM port names rather than the common name we had with VACs. This is necessary because the software is actually emulating a null modem so it has to have a port for each side of the device. You don't normally need to configure the virtual COM ports because they take their settings directly from the connected software. If you do want to make any changes, you just need to open the setup program and don't forget to click Apply when you've finished.

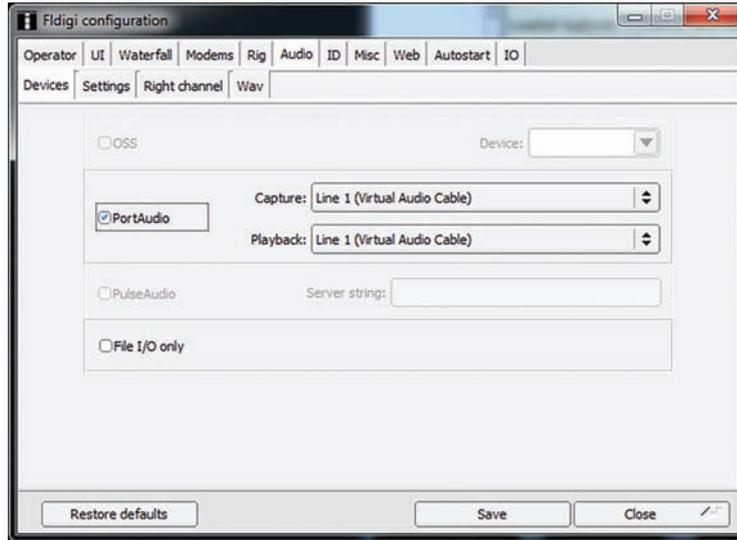


Fig. 5: The VAC showing in FLDIGI.

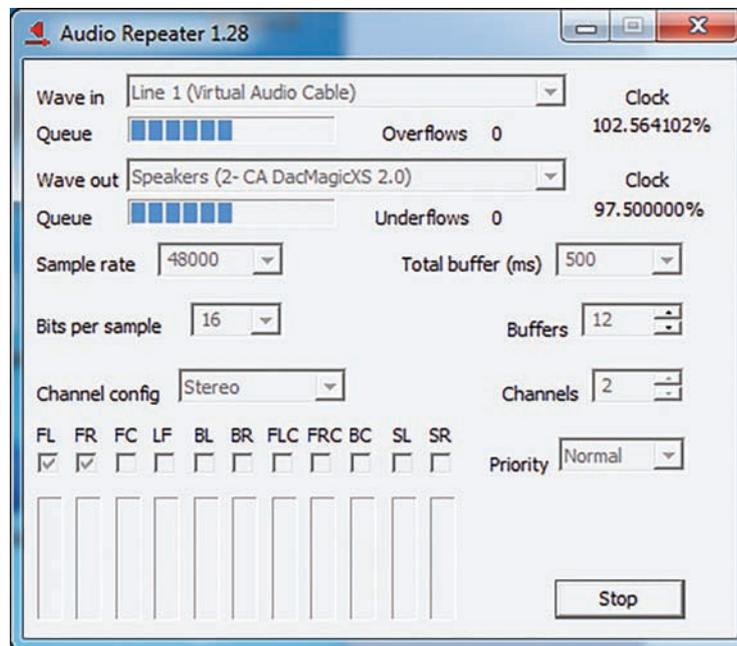


Fig. 6: The audio repeater that's bundled with VAC.

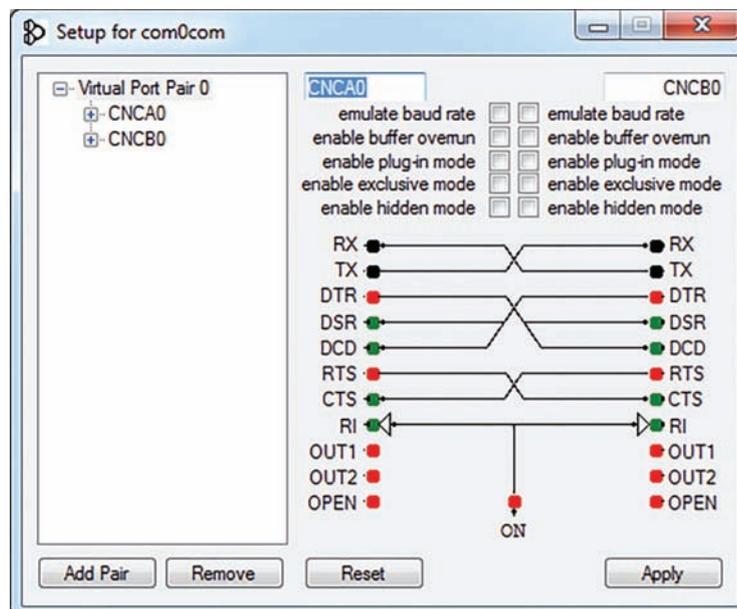


Fig. 7: The com0com control panel.